Vol. 20 SEPTEMBER, 1955 No. 9

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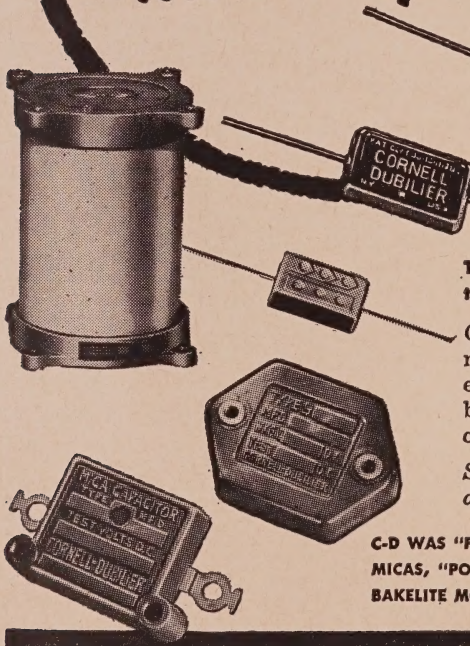

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NEGATIVE RESISTANCE DEVICES

Attention given to the phenomenon of negative resistance too often is transitory. Indeed, students have been known to account satisfactorily for their exposure to the subject and yet to have only the vaguest idea of negative resistance as a reality. It is surprising that so many successful technicians attach an "out-of-this-world" significance to the entire subject. But negative resistance is not the will-o'-the-wisp that it might appear. It is not just a mathematical abstraction but a very real property which can be exhibited by circuits or components.

The electronic technician knows positive resistance. This property shows up as an unavoidable factor in virtually every electric component. It also is provided deliberately and purposefully in rheostats, potentiometers, fixed resistors, heating devices, lamps, etc.

Positive vs. Negative Resistance

It is well understood that increasing the current flowing through a positive resistance will cause the voltage drop across the resistance to increase. When the current decreases, the voltage drop decreases. The opposite condition also is true. That is, increasing an applied voltage increases the current, and vice versa. These conditions apply to both linear and non-linear positive resistances. Figure 1(A) depicts the condition for a linear positive resistance.

A positive resistance consumes power (I^2R), and if the dissipative property of this parameter is not to be the end result, its effect must be kept to a minimum in a circuit.

When current through a negative resistance is increased, the voltage drop across this resistance decreases, and vice versa. This is an important property, since the instantaneous value of resistance (E/I) is positive at any point within the operating range but the slope of the corresponding EI static characteristic curve (See Figure 1B) is negative. A negative resistance therefore does not consume power, like the positive resistance, but in

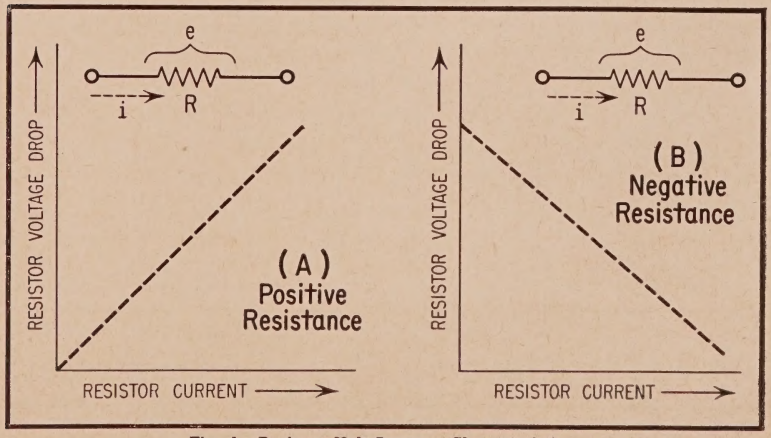

Fig. 1. Resistor Volt-Ampere Characteristics.

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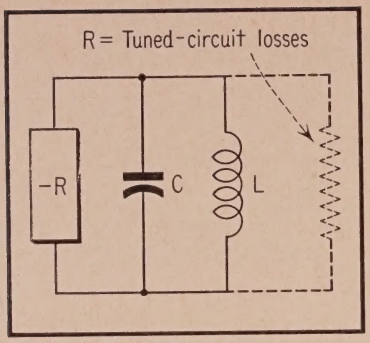

Fig. 2. Functional Arrangement of Negative-Resistance LC Oscillator.

effect supplies power to the circuit in which it appears. This generator-like property of a negative resistance enables the latter to provide amplification or to cause oscillation. Either of these effects may be sought as the end result in a particular design or may appear as a troublesome by-product of circuit operation.

Presence in Tube Circuits

A blanket statement often is made that a conventional vacuum-tube oscillator is sustained in operation because the positive-resistance losses in the tuned circuit are offset by the negative resistance supplied by the tube as a result of regenerative feedback. This is both acceptable and demonstrable. In general, an oscillator may be obtained by shunting a tuned circuit with a negative resistance of the proper magnitude with respect to the resistance losses and parallel resonant impedance of the tuned circuit (See Figure 2). In the case of the conventional vacuum-tube oscillator, however, the negative resistance is a by-product of feedback action. Negative resistance in this instance is not a component, a something that can be unsoldered and measured separately. For this reason, the common tendency is for technicians to regard it as a phantom introduced merely to make calculations come out right.

The physical reality of negative resistance in v-t circuits is better grasped by the practical man as it occurs in special oscillator circuits like the dynatron and transitron.

Dynatron. In the dynatron circuit (Figure 3A), the negative resistance appears between the plate and cathode of a tetrode tube and results from the

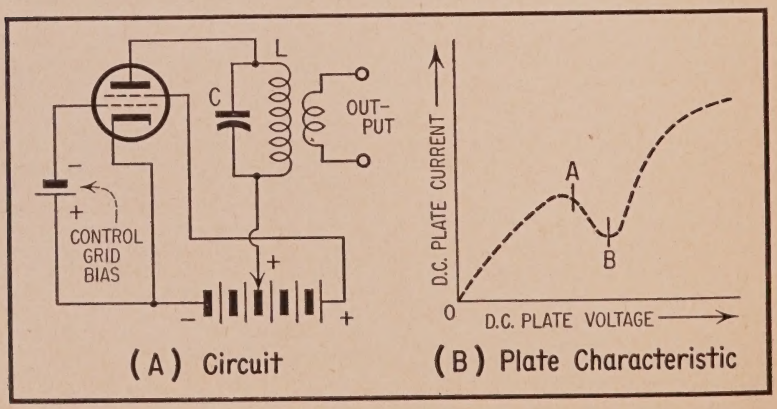

Fig. 3. Dynatron Oscillator.

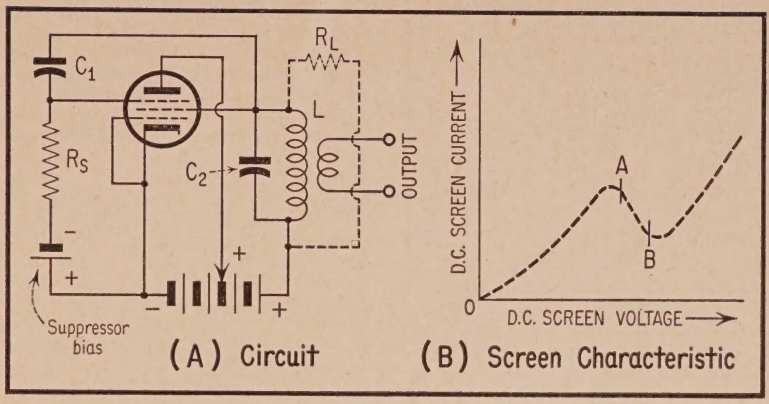

Fig. 4. Transitron Oscillator.

effects of secondary emission of electrons in the tube. The plate volt-ampere characteristic curve (Figure 3B) serves to clarify this action. Electrons from the cathode strike the plate with sufficient force to emit secondary electrons from the plate material. Up to a certain point (from zero to A in Figure 3B), the secondary emission effects are inconsequential and the plate current increases proportionately with plate voltage. The curve displays positive resistance in this range. At higher values of plate voltage, the secondary emission increases sufficiently to decrease plate current as plate voltage increases. This is shown in the region AB which displays negative resistance. Beyond point B, the plate and screen potentials approach equality and the curve again displays positive resistance.

When an LC circuit is connected to the plate of a tube operated in the negative-resistance region of its static EI characteristic, the basic configuration for a negative resistance oscillator (Figure 2) is satisfied. The d-c operating point is chosen near the center of the sector AB (Figure 3B) in the most linear portion of this slope.

The dynatron oscillator found its widest acceptance and popularity during the 30's principally as a standard-frequency r-f oscillator mainly in the amateur service. It is a stable oscillator with good output waveform. Its notable shortcoming, however, is its dependence upon secondary emission which is not so easily reproducible as other tube parameters and which varies with tube age. The circuit is partial to well-screened tubes like the now-obsolete Types 222 and 224.

Transitron. In the transitron circuit (Figure 4A), a negative transconductance is present between the screen and suppressor of a pentode tube. This property does not depend upon unpredictable secondary emission, so the transitron circuit therefore is more reliable than the dynatron. Figure 4(B) illustrates the screen volt-ampere characteristic with the negative resistance appearing between A and B. Sustained sinusoidal oscillations are obtained in a tuned circuit, LC_2, connected between the screen and the d-c screen supply. Capacitor C_1, which couples the suppressor to the screen, is chosen for negligible reactance (with respect to resistance R_s), at the resonant frequency of the LC combination.

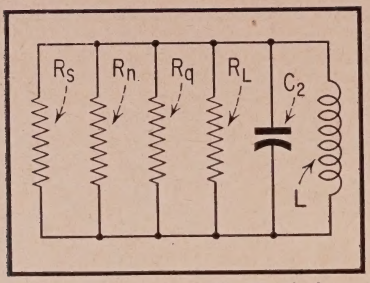

Fig. 5. Equivalent Circuit of the Transitron Oscillator.

In the transitron circuit, the total number of electrons emitted by the cathode is affected very little by the suppressor voltage because of good shielding provided by the control grid and screen. But the division of space current between the positively-charged screen and plate is influenced. Thus, an increase in suppressor voltage produces an increase in plate current and a decrease in screen current by increasing the number of electrons reaching the plate. Conversely, decreasing the suppressor voltage increases the screen current.

Region AB (Figure 4B) shows the suppressor-screen transconductance of the tube to be negative. The negligible reactance of C_1 results in the a-c screen voltage having the same polarity as that of the a-c suppressor voltage. A screen-cathode negative resistance accordingly appears, and the tuned LC_2 tank (Figure 4A) shunting the screen-cathode negative resistance satisfies the configuration for a negative-resistance oscillator shown in Figure 2.

Figure 5 shows the equivalent circuit of the transitron oscillator of Figure 4(A). Here, suppressor resistor R_s, resistor R_q representing the losses in parallel with the tuned circuit, and R_L representing the resistance load into which the oscillator operates, are positive resistances. Resistor R_n is the screen-cathode negative resistance of the tube. Constant-amplitude oscillations are generated when the power supplied by R_n equals the power consumed by R_s, R_q, and R_L. When R_n is too small with respect to R_s, R_q, and R_L, current through it (which is equal and opposite to the sum of the currents in the

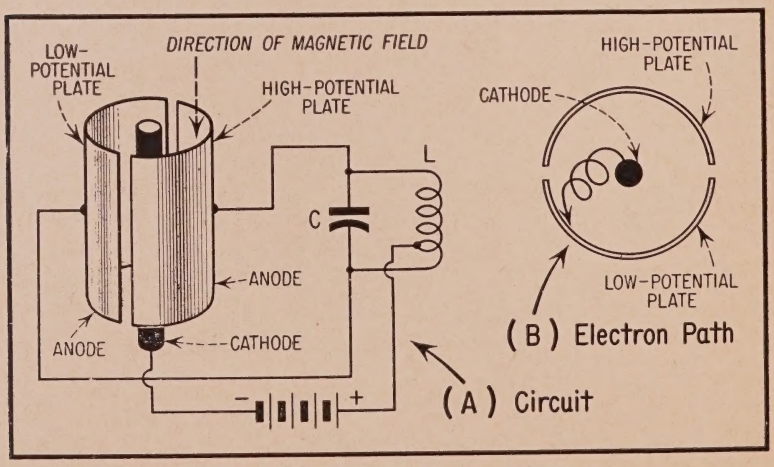

Fig. 6. Negative-Resistance Magnetron Oscillator.

other three resistors) is too low to sustain oscillations.

The transitron oscillator circuit is useful with any of the pentode tubes having separate suppressor terminals. Converter-type tubes often are used for the purpose.

Diode. Aside from its appearance in multi-element tube circuits, negative resistance has been noticed occasionally in diode tubes operated at very high frequencies.[1,2] This is due to the fact that transient-time effects cause the dynamic plate resistance of the diode to become negative at certain of these frequencies.

As the frequency is increased in the ultra-high-frequency region, the diode resistance decreases considerably from its low-frequency value. This resistance becomes zero when the transit time is equal to the period of 1 cycle of the operating frequency. At higher frequencies, the resistance fluctuates about zero, occasionally assuming a negative value.

The efficiency of the negative-resistance u. h. f. diode oscillator is low, and this undoubtedly is the main reason why this type of generator has not been exploited beyond the laboratory stage.

Negative-Resistance Magnetron. The spiral-shaped electron path (Figure 6B) in a split-anode magnetron tube

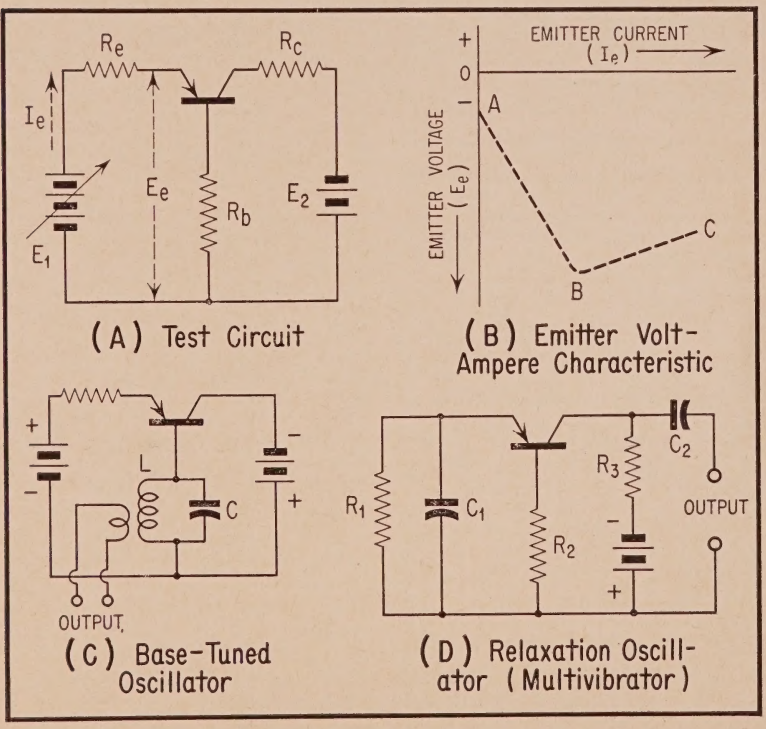

Fig. 7. Point-Contact Transistor Circuits.

gives rise to a negative-resistance effect which is presented to inter-anode voltages. This occurs when the anode potential and strength of the applied magnetic field are proportioned for cutoff.

In the circuit of Figure 6(A), one anode is at higher potential than the other, and the tortuous path causes some electrons, attracted in the beginning by the higher-potential anode, to arrive at the lower-potential anode. This is responsible for the negative-resistance effect. In Figure 6(A), the difference in potential between anodes is accomplished by the off-center tapping of coil L. Sinusoidal oscillations are sustained in the LC tank.

High efficiencies are obtained in split-anode negative-resistance magnetron oscillator circuits operated with intense magnetic fields and high-impedance LC circuits.

Point-Contact Transistor

In the point-contact transistor, but not in the junction type, the emitter-collector short-circuit current amplification factor (alpha) is greater than unity. The emitter input and collector output currents are in phase. These two circumstances make it fairly easy to obtain positive feedback in a common-base circuit in which the base resistance (internal or external) is of significant size. A byproduct of this feedback is the rendering of the resistance looking into the emitter-input negative over a considerable portion of the emitter volt-ampere characteristic. While this acts to make the point-contact type of transistor short-circuit unstable and necessitates many precautions in the application of this transistor, the negative-resistance characteristic proves useful and is readily adapted to simple oscillator, trigger, and flip-flop circuits.

Figure 7(A) shows a point-contact transistor circuit exhibiting negative input resistance, and Figure 7(B) depicts its d-c volt-ampere characteristic. Here, the collector is operated from a constant d-c voltage source, E_2, and the emitter from an adjustable d-c voltage source, E_1. The values of resistances R_b, R_c, and R_e in the base, collector, and emitter leads respectively depend upon the characteristics of a particular transistor.

A given positive emitter current (I_e) flows through the input circuit and produces a voltage drop across R_b. However, this current is amplified by the transistor and a somewhat higher current of opposite polarity (from E_2) flows in the collector circuit and also sets up a voltage drop across R_b. The dominant current thus determines the magnitude of the voltage drop across the base resistor and also its polarity. But the magnitude of the collector current also is proportional to alpha and becomes lower at high values of I_e, since alpha decreases with emitter current. This means that the voltage drop across R_b (which is also the emitter voltage, E_e) can have different values and polarity depending upon the value of emitter current I_e.

This can be demonstrated by increasing E_1 (and therefore I_e) positively from zero. The voltage drop E_e (as measured with a d-c vacuum-tube voltmeter) promptly increases **negatively** from A, eventually reaching B. Beyond point B, alpha begins to fall off and the collector current becomes progressively less important than the emitter current in determining the polarity and magnitude of E_e. Further positive increase of emitter current results in less-negative progress of emitter voltage from B to C.

Region AB is one of negative resistance, while BC exhibits positive resistance. This negative input resistance of the common-base point-contact transistor circuit is utilized in oscillator and switching circuits. A typical base-tuned LC-type oscillator is shown in Figure 7(C) and a relaxation-type oscillator (multivibrator) in Figure 7(D). The d-c operating point of the transistor in both circuits

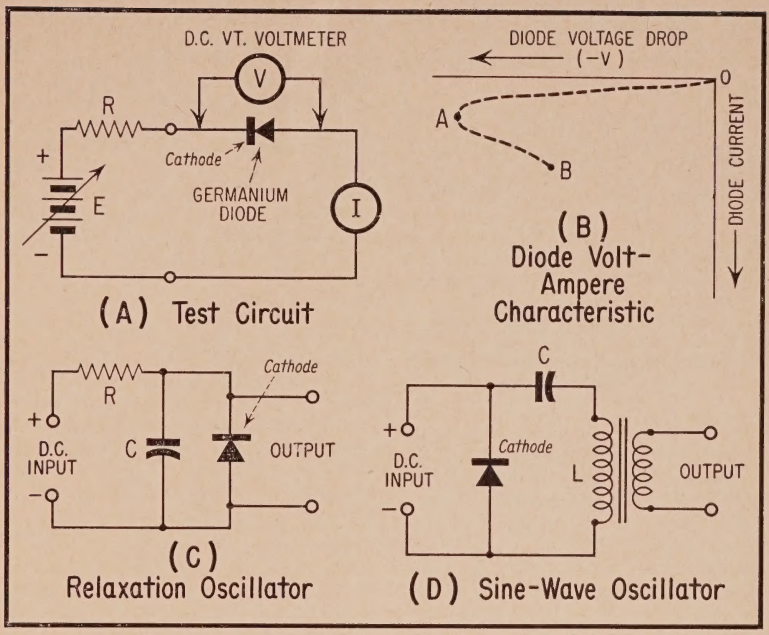

Fig. 8. Germanium Diode Negative-Resistance Circuits.

is selected within the AB region of the curve shown in Figure 7(B). Simple explanations of other negative-resistance transistor circuits may be found elsewhere.[3] It is interesting to note that another negative resistance effect is found in the d-c collector volt-ampere characteristic.

Two-Terminal Negative Resistance Devices

The electric arc ranks as one of the earliest two-terminal devices found to show negative resistance. However, the arc has not been used extensively as a radio transmitter for more than 30 years and it does not seem to warrant detailed mention here.

Reverse-Biased Germanium Diode. The best-known modern 2-terminal negative resistor is the reverse-biased germanium diode. This is shown in Figure 8. In Figure 8(A), the diode is reverse-biased (cathode positive) by the d-c source, E. This source and the series resistor, R, constitute a constant-current supply with adjustable output. As the diode reverse current is increased from zero, the diode voltage drop (V) is seen to increase non-linearly from zero to A (Figure 8B). As the current is increased further, however, the voltage drop decreases from A to B.. This appears to be an effect caused by internal heating: increased current raises the temperature and lowers the diode resistance, and the lowered resistance accounts for the decreased voltage drop.

The slope from A to B being negative denotes negative resistance. When the diode is reverse-biased to some point between A and B, this negative resistance can be utilized to obtain oscillation, amplification,

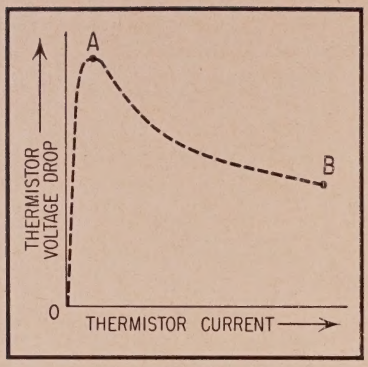

Fig. 9. Thermistor Volt-Ampere Characteristic.

trigger action, and voltage regulation. A tuned circuit in parallel with the diode, for example, satisfies the condition given in Figure 2 for a negative-resistance oscillator. Figure 8(C) shows a typical relaxation oscillator circuit; Figure 8(D) is a sine-wave oscillator.

Since the negative-resistance region of the reverse volt-ampere curve of the germanium diode is at some distance beyond the maximum recommended continuous operating voltage, this region represents an overload condition and has hampered development of long-life, practical, diode negative-resistance devices. The voltage at point A on the curve in Figure 8(B) is found listed in diode manufacturers' literature as the "reverse voltage for zero dynamic impedance."

Amplification in Diode Frequency Converter. Quite apart from the reverse-biased diode, North[4] has observed slight amplification effects in v. h. f. superhet receiver frequency converters employing some welded germanium diodes. This he attributes to a negative conductance region found on the converter response curve.

Thermistor. Like the reverse-biased germanium diode, the thermistor, a thermally-sensitive resistor, shows a negative slope over a large portion of its static volt-ampere characteristic. Figure 9 shows a typical thermistor static characteristic curve.

Increasing the current through the thermistor from zero to A produces a rapid increase in the voltage drop across this component. Beyond point A, however, further increase of current results in a decrease of voltage drop, such as from A to B, exhibiting negative resistance.

A thermistor biased to a point within the negative-resistance region of its static characteristic can be handled as a 2-terminal negative resistor to satisfy the general condition depicted by Figure 2. Thermistors have been used in oscillators, switches, modulators, and amplifiers.[5] Their dependence upon temperature variation, however, seems to limit their operation to low frequencies. Another limiting factor is the respectable rise in temperature above ambient in the negative-resistance portion of the volt-ampere characteristic.

Negative-Resistance Amplifier

Since we have alluded to ampli-

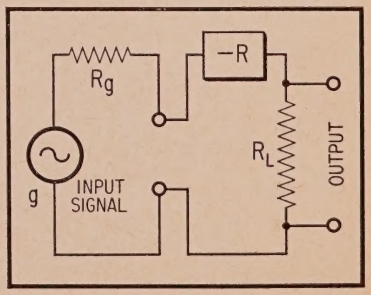

Fig. 10. Equivalent Circuit of Negative-Resistance Amplifier.

fication by means of negative resistance, especially in the discussions of the reverse-biased diode and the thermistor, the time has come to say something about this phenomenon.

The use of vacuum-tube negative-resistance circuits for 2-way amplification has been described in the literature.[6] But the technician and experimenter will be interested most in how amplification is obtained with the simple 2-terminal negative-resistance devices, even though this "feat" still is in the laboratory stage. Both diodes[7] and thermistors[5] have been used as amplifiers. (The negative-resistance diode amplifier is quite different from the recently-announced Bureau of Standards diode amplifier, which utilizes the reverse transient characteristic.)

Figure 10 shows the equivalent circuit of a negative-resistance amplifier. This treatment has appeared previously.[8] The negative resistance (—R) theoretically can be any such resistance. For instance it might be a germanium diode or a thermistor biased to the negative slope of its static volt-ampere curve. The input signal is supplied by a generator (g) having an internal resistance value of R_g. The signal voltage is applied to a circuit consisting of the negative resistance (—R) and a positive load resistance (R_L) in series.

If R_L is equal to R_g, the current flowing in the circuit due to the applied signal voltage (e) is: $i = e/(2R_g—R)$, and the output voltage is $eR_g/(2R_g—R)$. The gain due to the negative resistance thus is $2R_g/(2R_g—R)$.

A negative resistance amplifier of this type employing a 1N34 germanium diode, reverse-biased to approximately 100 volts dc and feeding into a load resistance of 3000 ohms, has shown a voltage gain of 4 at 1000 cps, with an input signal level of 5 volts rms. (See Reference 7.)

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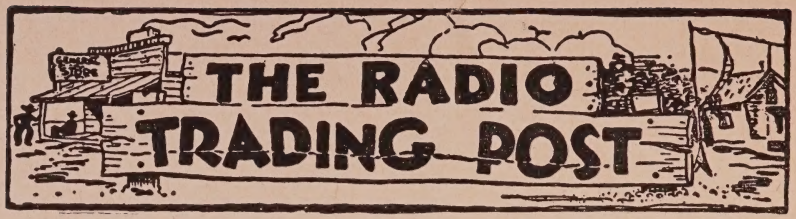
8. **Feedback and the Grounded-Grid Amplifier,** George F. Cooper, RADIO-ELECTRONICS, October, 1952, p. 46.



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SELL — Sams Photofacts folders 74, 82, 97 and 97A, 102, 117, 132, 137, 207, also Riders No. 41. Perfect cond., 1 schematic per folder used, $1 per folder, plus postage. C. Elgasser, 1920 Fern St., San Diego 2, Calif.

FOR SALE — Eico 425 oscilloscope; Eico sweep gen,, never used. Best offer takes it. Ed Morawski, 8640 Warren Blvd., Centerline, Mich.

SELL OR TRADE — Web-Cor tape recorder and Pilot Hi-Fi FM-AM tuner. Cash or trade for what have you? Walter Bartell, 1107 N. Western Ave., Chicago 22, Ill.

FOR SALE — Heathkit communications rcvr. model AR-2 in cabinet, factory calibrated, $20. Arnold Moskowitz, 213-02 75th Ave., Bayside 64, N. Y.

FOR SALE — Sonora portable radio, $7.50; Williamson amplifier, Partridge WWFB output xformer, two chokes, KT66 tubes, new cond., $75. Donald P. Bargen, 418½ East Gregory Ave., Rockford, Ill.

FOR SALE — 2 GE selsyn gen. No. YA4 model 2J1F1 115-57.5 v. 400 w.; Masco tape recorder; Silvertone wire recorder, record turntable, 117 v. AC; Heathkit sig. gen. model G-1 converted; Knox and Fleron standoff insulators. Joseph A. Czukiewski, R 1, Ebensburg, Pa.

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SELL OR SWAP — Hallicrafter S-36 VHF rcvr. 27-144 mc. AM-FM can be rack-mounted for lab use, $95; pair of unused SCR-536 Handy-Talkies 3.885 kc. with batteries and tech manual, $100. M. L. Bardfield, 4 Brinsley St., Boston 21, Mass.

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FOR SALE — Magazines, most issues complete 1933 to date: Proc. of IRE, Electronics, Radio News, Radio Craft, Service, QST, Audio Engineering. Lando K. Moyer, Bedminster, Pa.

SELL OR TRADE — Automatic duplicator; 3-way Bendix portable radio. Want small screen TV; new tubes; test equip. E. G. Bartlett, Atlanta, Mo.

FOR SALE — Webcor 210-1B tape recorder with mike, reels and tape, $95; Rider chanalyst 11A, $50; Hickok 277X sig. gen., $69; rcvr. SW-54, $27.50; RCA 621, 7" TV, $25. A. C. Livingstone, 12-01 Ellis Ave., Fair Lawn, N. J.

WANTED — McMurdo Silver model 903 wavemeter with or without coils, also 5 v., 15 amp. fil. xformer. Thomas L. Comport, 2013 Weeks Ave., Superior, Wis.

WANTED — Surplus Conversion Manuals No. 1 and 2; GE Baton tone arm model A1-501 for 16" records; BC 474 xrcvr. M. J. Douglas, 1401 Amador, Concord, Calif.

SELL OR SWAP — Emerson 665 TV R-P, $60; RCA 811K radio, $23.50 and B10K, $19.50; Philco 41-608 R-P, $25; Revere chime clock, $59.50; Hobart kitchen aid mix, $39.50; GE 250 radio, $49.50. R. G. Devaney, 631 So. 60th St., Philadelphia, Pa.

SWAP — S-9 Hallicrafter; Eico 320 sig. gen.; Meissner analyst; Eico VTVM; Heath vibrator tester. Want field strength meter; Riders manuals 17 to 20. Lovett's Radio and Key Shop, Newland, N. C.

WANTED — Tape recorder and 8 mm. Cine projector, used but in operating condition. Chas. Wendell, 19 Donald St., Bloomfield, N. J.

FOR SALE — Used radio parts, speakers, amplifiers, radios phono motors, inverters. Pat McDonald, 195 Prince St., New York, N. Y.

TRADE — BC-2-603-D, new condition, make offer. Charles Radio Service, 81 Warren St., Roxbury 19, Mass.

TRADE — 600 popular type radio and TV tubes and assorted test equipment for tape recorder, Hi-Fi equipment. Herbert Piller, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

WANTED — Police alarm FM radio model PR-8. State lowest price. Botbyl Radio Shop, 1009 Sophia St., Muskegon, Mich.

SWAP — TBX, 2 to 6 mc., xmitter-rcvr., has two crystals and self-exciter; also 12 v. input dynamotor 0-500 v. Want medium communication rcvr. in working cond. Peter Mendez, 3655 Locust Ave., Seaford, L. I., N. Y.

WANTED — Heathkit VTVM, sig. gen., TV sweep gen. Prefer inoperative or incompleted kits. Trade tubes, relays, xformers, etc. What do you need? L. G. Maxwell, 1016 No. Richard St., Carlsbad, N. M.

FOR SALE — Riders manuals 1 to 5 condensed (one volume) 6 and 8, and 10 thru 14; Sams Photofacts 37 to 86 with 4 binders. All good cond., $50 for all plus shipping. John Talbott, 208 South High St., Draper, N. C.

WANTED — Power supply 800 v. DC at 300 ma. in trade for xmitting tubes, xfmrs, variable condensers, instruments. Joyce Shanks, 38533 31 St. E, Palmdale, Calif.

SELL OR TRADE — Rider TV manuals to 12, $120; Rider Perpetual trouble shooters manual 1 to 18 and 22, $120. Want cash or good TV tubes. ACA, 1111 E. Elizabeth Ave., Linden, N. J.

FOR SALE — Harvey-Wells TBS-50-C; 6 v. input Carter Geneamotor 425 v. 275 MA filter and relay; Shure coiled cord mobile mike; mobile antenna 20 and 75. Latest type Lees Neville 6 v. 100 a., also instruction books. Mark Potter, 233 E. Ave., Park Ridge, Ill.

SELL OR SWAP — Electric Instructograph with 10 tapes, l. n. cond., $25 or swap for what have you? O. E. Radke, 3801 N. Newhall St., Milwaukee 11, Wis.

FOR SALE — 12" Rola and Jensen E. D. speakers, $7.50 ea.; 2 xtal mikes, $5 ea.; RCA 8" MI6234A speaker, $7.50; unused Zenith AM-FM radio H725, $55 prepaid; Radio Craftsman 17" RC-100A TV tuner, $125. I. A. Eilers, Gladbrook, Iowa.

WANTED — Technical maintenance manual for AN/APN-4 Loran, and APG-5 or APG-13 radar. Also want CW-3 rcvr. Cash or swap . R. W. Farrell, 111 18th St. SE., Rochester, Minn.

SELL OR SWAP — Elmac A54H ham xmitter, 10, 11, 20, 40, 75 meter band-switching with push-to-talk oper., $90; dual vibrator power supply, 475 v. at 250 ma., for above rig, $25; Want light-weight English-type men's bicycle. L. A. Wortman, 2780 Rockaway Ave., Oceanside, L. I., N. Y.

FOR SALE — Masco TVB53 Cascadian VHF two-stage booster, increases sig. 56 times, 35 db, all VHF channels in factory sealed carton with 90-day guarantee, $20 postpaid. Stanley C. Flotte, 1822 Moss St., New Orleans 19, La.

FOR SALE — Espey 14 tube AM-FM tuner 512B, $70; Heath W3 amplifier, $40; Altec Lansing 603B speaker in Klipsch Cabinart KR4W mahogany cabinet, $135. All display items. Tompkins Sq. Radio, 117 East 7th St., New York 9, N. Y.

FOR SALE — Eico 322 sig. gen., $12; Jackson 645 vac. tube voltohmeter, $35; Heath 5" model 09 scope, $75; Heath TS3 sweep and marker gen. $55. All equip. precision calibrated and l. n. cond. S. L. Samoles, 619 E. Market St., Scranton 9, Pa.

SALE — Webcor tape recorder, records in both directions, $150; Eico tube tester CRT harness, $30; Precise VTVM, $25. Want TV-Radio position as serviceman in Los Angeles or San Francisco or Las Vegas Area. O. Franz, 1527 Liberty St., Erie, Pa.

FOR SALE — Carter rot-conv., DC to AC 60 v., DP., 115 v., 2.2 A., 3600 rpm, 200 KVA, $40; Bell-Tape Re-Cord-o-Fone RT65B, perf., $90; Precision sig. gen. E200, $35; 20 w. sound amp., mike with stand, $40. Franklin Slay, 243 West 107th St., New York 25, N. Y.

WANTED — ART-13, ARC-1, APR-4, TN-16, 17, 18, 19, 54; ARN-7, TDQ, BC-221, TS-173, Boehme equip., BC-610, BC-614, BC-939, radar, manuals. Cash, or trade for new Viking, Ranger, Hallicrafters, Hammerlund, Gonset, Elmac, National, Fisher, Pentron, etc. Alltronics, Box 19, Boston 1, Mass.

SELL OR TRADE — 3 Westinghouse 5736 tubes, and 2 4J34 tubes, in perf. cond.; 2 used Facsimilie transreceivers model TT-1B/TXC-1. J. W. Phillips, 5807 No. Belt, West Belleville, Ill.

WANTED — Impedance bridge, condenser, resistor decades, VTVM .01-50 AC, electronic switch for scope, voltage calibrator, tube checker late model with gas test, audio gen., Rubicon or L and N Potentiometer, bridges. Complete data, conditions, prices. P. Kilpatrick, 1030 Curtis, Albany 6, Calif.

FOR SALE — Perfect Webcor 2020 tape recorder, with factory warranty, also Pentron HT 225, used demo., $145 each. Both have mikes and reel of tape. W. Murphy, 4217 East 4th Ave., Hialeah, Fla.

WANTED — Scope model 425 or similar, must have push-pull amplifiers in vert. and hor. Swap for scope, amplifiers, 17" TV set, 16 mm. projector, cash, 120 bass accordion with case, fans, motors, etc. John Arnold, Box 84, Bluffs, Ill.

WANTED — Schematics and data for RCA amplifier model M-1224-Y; instructions for SPECO sig. tracer, also sig. corps manual for BC-474 transceiver. A. Nutkis, 121 Wegman Pk., Jersey City 5, N. J.

WANTED — EMC models 102 and 103 VOM in any condition providing meters are good. Have 20 w. amplifier, 6 v. dynamotor at 400 v. 150 ma., novice xmitter, 400 v. vibrapack, 40 w. modulator, supply 800 v. at 275 ma. Stanley J. Zuchora, 2748 Meade St., Detroit 12, Mich.

SELL OR TRADE — Master mobile mount, includes chrome base and spring, $7.50 cash, or trade. Edwin Sheldon, Box 721, Aberdeen, So. Dak.

FOR SALE — 20" TV conversion kit including new 20" picture tube, 14000 v. fly-back xformer, 70 degree deflection yoke, width coil mask and glass protective face, $15 FOB. John O. Hehn, 18 S. Jardin St., Shenandoah, Pa.

WANTED — 1954 or later new or used issue Amateur Radio Call Book. C. B. Kelley, 7204 Clovernook, Cincinnati 31, Ohio.

FOR SALE — Waterman industrial scope 3" model 11A, l. n. cond., $70. H. I. Griffiths, 39-82 65th Pl., Woodside 77, L. I., N. Y.

WANTED — Riders 12 thru 15 inclusive. For sale — Hallicrafter 7" TV and Zenith 12½" TV, both running cond., best offer over $28; RCA 10" $38. John De Frees, Durhamville, N. Y.

WANTED — Information on diagnometer model 585 Serial 585-230. Radio Service, 2401 Hiawatha Pkwy., Columbus, Ohio.

SWAP — 750 600 v. bathtub capacitors double .5 mfd. for good typewriter or what have you? A. Stratmoen, Lock Haven, Pa.

FOR SALE — UHF, B-T lab. converter model 99, l. n., $9; VHF Booster, Astatic model AT-1, $11; V-M Tri-o-Matic model 955 record changer, all speeds and record sizes, $14 FOB. Industrial Soc., 204 Dauphin Bldg., Harrisburg, Pa.

SWAP — TV test equip., 20 w. McIntoish Hi-Fi amplifer, UHF converter, Pilot transceiver model 101 (marine band). Want guns. Bill Bockman, 400 Single Ave., Collins Pkwy.,New Castle, Del.

FOR SALE — Tube checker in good shape new roll chart, EMC model 200, $25. Greiner Radio TV Service, 299 South Elmwood Ave., Buffalo 1, N. Y.

WANTED — Echophone EC-1 radio in good cond. John A. Diaz, 2239 So. Layton Blvd., Milwaukee 15, Wis.

WANTED — Audio sweep generator, Hewlitt Packard, Ballantine or similar VTVM; also lab. standard test equip. of all types. W. Oppenheimer, 70 Hill St., Brooklyn 8, N. Y.

FOR SALE — Gonset 3-30 converter, used 40 hours, $24; shipped pre-paid; Zeiss Tessar f3.5, 120 mm lens mounted in Compur shutter on 3¼-x-4¼ German view camera. Best offer. R. Brokloff, 188 Blaine St., Johnstown, Pa.

FOR SALE — Radio News, Radio Craft, QST, CQ, Radio, from 1920's to 1950's. P. L. West, 3108 Varnum St., Mt. Rainier, Mo.

FOR SALE — Sonar VFO, BC-625 xmitter for 100-150 mc.; Army power supply, model PP-104/APT-5. Best offer takes any or all. Bill Kress, 201 Norman Rd., Camp Hill, Pa.

TRADE OR SELL — Unused Johnson Viking II wired, complete and VFO wired but not calibrated for Hickok or Precision portable dynamic tube or tube-set tester, late model plus cash. Bob Eubank, 1227 Windsor Ave., Richmond 27, Va.

FOR SALE — Riders manual 1-5 ABR., 6-15, $5 each or trade for 5" scope. Reali Radio, 90 Wall St., Amsterdam, N. Y.

FOR SALE — Power Plant Engineer Dec. 1946, all 1947, '48, and '49, 1950 thru May; Communications all 1947, '48, and '49 less Dec.; Television Engineering 1950 less June, all 1951, Feb. 1952. D. C. Harrington, 2508-B 36th St., Los Alamos, N. M.

FOR SALE — Complete radio, TV bench and panel mounted instruments, $1700. Tools and working top bench, all in one unit. Will send picture if interested. Loyd E. Ritts, 644-N-7th Ave., Tucson 10, Ariz.

WANTED — Ship to shore radiophone or what have you in Marine equipment. Bazewick, 11221 NE 9th Ct., Miami 38, Fla.

FOR SALE — B & W CX62C with N3 neut. condensers also B & W HDVL 20 meter coil with jackbar and swinging link. complete, $20. Art Bonte, 3138 Kingsbridge Ter., Bronx 63, N. Y.

FOR SALE — Hammarlund super pro rcvr. 100kc to 20 mc. band with RME DM36 10 meter converter and power supply, lo-freq. band on rcvr. converted to BC, clean cabinet, top running cond., $85. Will deliver within 100 miles. George J. Sallet, 28 Central St., W. Concord, Mass.

WANTED — Aircraft equip., such as Bendix PATR 10, Hallicrafters CA-2, CA-4, GE AS1B, and VHF. Franair, 19 Oakwood Ave., Saylesville, R. I.

SELL OR TRADE — Royal heavy-duty typewriter in A-1 cond. for good short wave rcvr. or cash. John P. McCullen, 3050 Bainbridge Ave., Bronx 67, N. Y.

TRADE OR SELL — Eico 425K oscilloscope factory wired, never used, $50; Sylvania 219 tube tester latest model, $65; Hickok 530 tube tester easily modernized, $15; radios very reasonable. Sam Berenblum, Greenwich, Conn.

SELL OR TRADE — Automatic duplicator, GE self-charging portable, 3" scope, tracer, generator. Want small TV, guns, recorder, or what? E. G. Bartlett, Atlanta, Mo.

SWAP — Older type radio tubes for later ones or what have you? Center TV and Radio, 867 Broad St., Central Falls, R. I.

SWAP OR SELL — Eico 470 7" push-pull scope with instructions, wired, working, ex. cond. and Eico sweep gen. for good tape recorder. Answer by tape, using 3¾ or 7½ speed dual track. Omer J. Demarest, 89 West St., Green Island, N. Y.

FOR SALE — 800 unused one-watt resistors, JAN-type, ceramic body. Best offer. S. Consalvo, 4905 Roanne Drive, Washington 21, D. C.

TRADE — Four 2-20 w. industrial flourescent fixtures or 1. n. Remington 60 electric razor for good used 3" RCA scope (with instruction book) or equivalent. Lee Bernholz, 634 High St., Newark 2, N. J.

FOR SALE — Sprague Tel-ohmike TO3 with service manual, $30. F. Gargulinski, Shrewsbury, Mass.

FOR SELL OR TADE — SX-42 and matching speaker in good shape, $125 or will trade for S-40A and cash. George E. Hausske, 1922 E. Indiana St., Wheaton, Ill.

SELL OR SWAP — VTVM, $25; wire recorder, $50; BC-221, $75; 5" scope, $65; sweep, $85; FM 6 tube, $20. Want cash, ST2A GE, W056A RCA, Photofact's from 130 UP, CIRE Master Course. J. Pellock, 899 W. Main, Decatur, Ill.

PARTNER WANTED — State approved Radio Technical School, only one in area to train under GI Bill. All necessary equip. installed. Should know radio repair and able to teach TV begin Fall, 1955. K. H. Stello, 4504 Hartwick Rd., College Park, Md.

SELL OR TRADE — Hi-Fi amp. custom built, $65 or trade for comm. rcvr. S. Swetzoff, 149 Intervale St., Boston 21, Mass.

WANTED — Any type of short wave rcvr., also an audio oscillator with or without speaker. Bertil Johnson, R. 3, Box 46, Princeton, Minn.

SWAP OR SELL — Precision: E200, RF sig. gen. and 8S6G VOM; Hickok 203A VTVM; RCA voltohmyst; Heath: 5" scope, 6 w amplifier with preamp; Superior pocket VOM; Eico 360 sweep gen. Herbert Piller, 749 Beck St., Bronx 55, N. Y.

FOR SALE — Eldico TR-75TV xmitter with 40 and 80 meter coils, low pass filter, never used, $75; Riders manuals 8, 10, 11, 13, 14, $6 apiece. Melvin Saur, Kent City, Mich.

WANTED — Pair of tuning shafts about one and half ft. long for Motorola 409 auto radio. Have TV schematics and service notes, assorted makes. Herbert Seligson, New City, N. Y.

SELL OR TRADE — Heath TV sweep gen.; Philco projection tube TP400; Hi-Fi 10 w. amp., FM tunner with AFC; RCA AVR11 airport four band rcvr., trans. and rcvr. for remote control. What have you? Anthony Wilczynski, 3223 Unruh Ave., Philadelphia 49, Pa.

SWAP — RCA test osc. for volumes 1 to 5 abridged and volume 9 of Riders manuals. Out-dated tubes at reasonable prices. Lionel Verble, Box 2, Vanduser, Mo.

FOR SALE — 12 tube AM-FM tuner, approved A-710, exc. cond., $22; BC-348-Q, exc. con., $55. Charles W. Leigh, 162 Passaic St., Trenton 8, N. J.

SELL OR TRADE — FM tuner AFC; 10 w. Hi-Fi amp.; RCA short wave airport rcvr.; TP400 projection tubes; four 829B trans. tubes; Chevy radio; trans. and rcvr. for remote control. Albert Ocharski, 2005 E. Madison St., Philadelphia, Pa.

FOR SALE — Riders vols. 1 to 5 TV Rcvr. Trouble Cures; Sam's TGL-1, 2, 4 TV Tube Location Guides; Sam's DC-2, 3, 4 Dial Cord Stringing Guides, 50% discount. Ed Larson, Ostrander, R. 2, Ohio.

SELL OR TRADE — BC-639 rcvr. with RA-42 power supply, new cond. for good jeep or jeepster. Also have unused TA-12D xmitter and LM freq. meter. Robert R. Jessup, Vandalia, R. 2, Ill.

FOR SALE — Unused Hickok 156-A with guarantee, $110; Clough-Brengel model 127 scope and modulator, $35; auto Radios. Paul Capito, 637 W. 21st St., Erie, Pa.

FOR SALE — Radio-TV shop good location, rent $30 mo. with living quarters in rear. Good stock of parts, radios and TV sets condenser checker, tube tester. Sell cheap. Donald Schotanus, 1864½ Glendale Blvd., Los Angeles 26, Calif.

SELL OR SWAP — Complete $350 RTTA AM-FM TV correspondence course 118 lessons plus math course for $60 or VTVM or tube tester. R. M. Gervais, 8 Spring St., Westbrook, Me.

FOR SALE — 2 meter xtal convertor, $12.50; 522 converted, 6 v. filaments, $25; power bias and rcvr. supply in one, $20. All for $45.50 COD. Ralph M. Peck, 2538 S. Robinson St., Philadelphia 42, Pa.

FOR SALE — NRI advanced radio and communication course, complete with experiment booklets, multitester in factory case, and parts to build xmitter, very good cond., $75. Steve Spevock, R. 2, Rivesville, W. Va.

FOR SALE — Garrard model 90 changer, l. n., $50; radio music transcription table 33⅓-78 rpm, $40; Meissner disc recorder, radio P.A., portable, $75; 12½" TV set, $35. Cash FOB. A. R. Dayes, 29 Charles St., Merrick, L. I., N. Y.

FOR SAFE — Hammarlund HQ-129-X, exc. cond.; Meissner EX sig. shifter. A. J. Camp, 1131 E. 27th St., Erie, Pa.

FOR SALE — Unused Meissner 9-1154 home music system: AM-FM tuner, phono-changer, amplifier, coaxial spkr. mahogany cabinet, all Hi-Fi, $150. Arthur Hofer, 717 Monroe Ave., Plainfield, N. J.

CASH OR TRADE — Hallicrafter S-58; Zenith transoceanic clipper; R.C.P. signaliner; 3 speed Hi-Fi radio comb., cond. tester; signal gen., radio course, etc. Exch. lists. Grey Mather, 722 Charlotte St., Utica 2, N. Y.

SELL OR TRADE — Modulation xfrms, BC221, 639, 638, RA42, Collins 32V, 30k; 310 B1, NC57, RKD and BC1032B panadaptors, power supply components, BM interrogator, Elmac gear, 6 v. dynamotors. George Pasquale, 9421 Thornhill Rd., Silver Spring, Md.

FOR SALE — Hickok electronic volt-ohm capacity milliammeter model 209A, $85. Edward M. Wrabel, 19 Newman St., Gloversville, N. Y.

FOR SALE — Zenith 5 bands portable 3 way special deluxe, good cond., $25; Oak Ridge model 103 sig. gen. FM-TV bands, $20. Humbert Torrese, 257 East 7th St., New York 9, N. Y.

FOR SALE — S40A Hallicrafter rcvr., good cond., $50 plus postage. Ervin Koenig, 1202 E. 8th St., Marshfield, Wis.

WANTED — Detroit area radio amateur to finish 2 meter station for busy engineer, in exchange for cash and equip. George H. Amber, 19925 Schaefer Hwy., Detroit 35, Mich.

FOR SALE — Exciter, all band Sonar VFX-680 complete with tubes, coils and instruction manual, good cond., best offer. A. B. Witzl, 1645 Campbell Ave., Des Plaines, Ill.

SWAP OR SELL — Simpson tube tester; Supreme tube tester 504A; Radio City 315 tube tester; Scott radio chassis chrome finish; Webster record changer 78 rpm. Want test equip. or tape recorder. Harold Wurm, 1015 W. Grant St., Appleton, Wis.

FOR SALE — Hallicrafters S-38, $27.50; six Sigma 4F8000S relays in original boxes, $3.50 each. M. Moses, 2526 Scioto Trail, Portsmouth, Ohio.

TRADE OR SELL — NRI Radio-TV course, 65 lessons, complete, $25 or typewriter in working condition. No reasonable. Offer refused. Joseph C. Similo, 2821 Castor Ave., Philadelphia 34, Pa.

FOR SALE — Transmitter Globe King 400, $250; rcvr. RME-45, $100; Preselector RME-DB 22A, $35. George Knudsen, 3619 Kelly Way, Louisville, Ky.

FOR SALE — Webster-Chicago model 80 wire recorder, $40 or best offer. John R. Willis, Passaic Ave., Caldwell, N. J.

SELL OR TRADE — 8 x 10 Eastman 2-D view with extension B & L wide angle lens and photographic equip. for good tape recorder. T. J. Tronson, Lake Villa, Ill.

TRADE — Lott rotary drier, Bromberg B paper safe, Federal 279 enlarger, 4" x 5" contact printer, Star D tripod, etc. Need 6-band converter, PE103A dynamotor, all good cond. Morton Cupingood, 297 Hawthorne Ave., Newark 8, N. J.

FOR SALE — Sylvania 140 tube checker counter type, latest tube chart, can check CRT's, $30. Swap 240 Hammeter for Heath VTVM. T. E. Champion, 669 Swan, Terre Haute, Ind.

SWAP — Korelle 2¼ x 2¼ single lens reflex camera with Schneider-Kreutsnach f2.9 lens speeds 2 sec. to 1/500, built-in self-timer and automatic film-transport, case and straps for dual-speed tape recorder in good cond. Wilbur Hull, Box 18, Cassadaga, Fla.

SWAP — Excellent Granco Star UHF converter, two Regency boosters, two UHF antennas, 20-foot double yagi, 500 feet tubular lead-in, 400 radio and TV tubes. Want cameras, enlarger, any photographic equipment. Bud Walsh, 1764 Foxworthy, San Jose, Calif.

FOR SALE — 3" scope; AC-DC battery portable radio; Heath TS-3 sweep gen., V-6 VTVM, and T-2 sig. tracer;; power supply, laboratory type; multimeter; 30,000 high voltage probe; electronics books. Stanley Bombka, 8107 N. Odell Ave., Niles 31, Ill.

FOR SALE — Like new General Radio Co. Variac model 50A variable output xformer, input 115 v. 60 cy., output 0-115, 0-135 at 45 amp. Best offer over $75. Harvey's Radio Service, 200 Stonecliff Dr., Rochester 16, N. Y.

POSITION WANTED — Electronic Technician with over 12 years' experience as tester, gov't inspector, and service technician on radio, TV, PA, test equip. Desires position as electronic tech., quality control inspector, or similar. Harry Hatfield, Box 24, Glen Cove, L. I., N. Y.

FOR SALE — GE, 1. n., TC3P tube checker, late model, $51 delivered — cash with order. National Radio Service, 594 Larkin St., S.W. Apt. 567, Atlanta, Ga.

WANTED — 1951-52 Chevrolet auto radio in repairable cond.; NRI xmitter Al shape Heathkit model IT-1; isolation xformer in good cond. Vernon J. Kroh, New Salem, N. D.

WANTED FOR CASH — Sams Photofact folders sets 226 to date and complete. State if in binders, cond., and price. Earl W. Wells, 223 North Philadelphia St., Shawnee, Okla.

FOR SALE — UTC 3A audio equalizier, $75; Electro Voice 600D dynamic microphone, $12; Signal Corps I-203A Thermistor power meter, $20; Signal Corps test set type I-148A, $5. Milton Robinson, 5 Koon St., Troy, N. Y.

SELL — At cost, radio, electronic equip. or appliances in exchange for new or used 2½ or 2 hp. 4-cycle gas engine, garden tractor wheels, parts, etc. or HO gauge train equipment. Frank A. Dawson, Box 337, Republic, Mich.

FOR SALE — Regenerative grid dipper with AC power supply, coils and 3" zero to 500 micro-amp meter, $15. N. L. Parker, 1240 Bedford, Detroit 30, Mich.

WANTED — Radiola 4, 16, 25, and Radiola Grand, Kolster Decrimeter and Pacent SLF condenser. Will pay cash. Donal Eymard, 140-35 58th Rd., Flushing 55, N. Y.

FOR SALE — Broadcast ARC-5 rcvrs. (.52-1.5 kc.) in original cartons, $20 each plus postage; SM-3 El-Tronics Gieger counter with new batteries, $150. J. Snow, 1011 N. Forrest, Altus, Okla.

WANTED — Tape recorder in good cond., Ampex, Magnacord or Concertone complete with accessories. State price for quick cash sale. T. J. Campbell, 1900 Washington St., San Francisco 9, Calif.

WANTED — RA-52 Signal Corps rectifier unit. Must be in good cond. Will trade electric motors. Sandis E. Regan, Box 183, Hebron, Ind.

SELL OR TRADE — Astatic AT-1 TV Booster; General Industries disc recorder 33-78 rpm; turntables; Western Electric tubes 284D, 211E, 261A; assorted meters; Pilot 601 FM tuner unassembled. H. Harrison, 300-37th Way, Sacramento 16, Calif.

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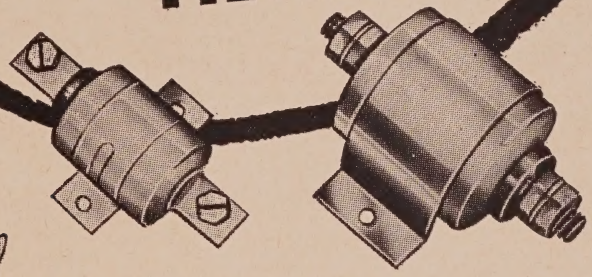

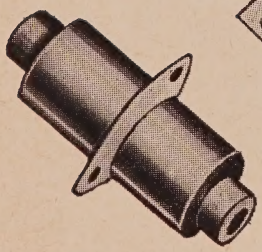

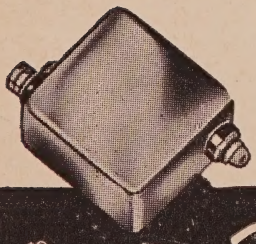

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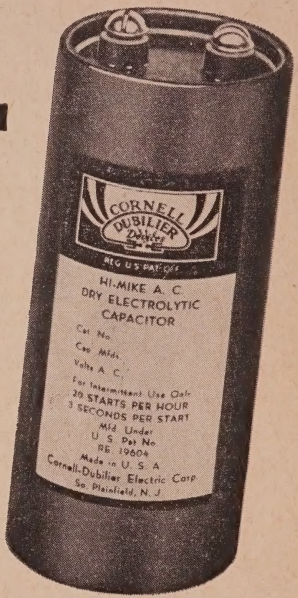

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